



QUESTION WORKBOOK

Millikan's oil drop experiment

Turning points · Year 13

AQA 3.12.1.4

10 questions · 28 marks

PRINT EDITION

SECTION A · Warm-up

- A1** Write down the condition for a charged oil droplet to hang stationary between horizontal parallel plates, defining every symbol. [2]

- A2** State Stokes' law for the viscous force on a small sphere, and the conditions under which it applies. [2]

- A3** State the conclusion Millikan drew from measuring the charges on hundreds of droplets. [2]

SECTION B · Standard

- B1** A droplet of weight 1.632×10^{-14} N hangs stationary between plates 6.0 mm apart when the pd is 612 V. Calculate its charge, and state how many electrons' worth it carries. [3]

- B2** With the field off, a droplet falls at a steady $1.2 \times 10^{-4} \text{ m s}^{-1}$. Using $\eta = 1.8 \times 10^{-5} \text{ Pa s}$ and oil density 880 kg m^{-3} , calculate the droplet's radius and mass. [4]

- B3** The droplet of the previous question carries two electrons' worth of charge, $3.2 \times 10^{-19} \text{ C}$. Calculate the pd needed to hold it stationary between plates 5.0 mm apart. [3]

- B4** Explain why the falling measurement with the field switched off is an essential part of the experiment. [3]

SECTION C · Stretch

- C1** Three droplets in one run carry charges $3.2 \times 10^{-19} \text{ C}$, $4.8 \times 10^{-19} \text{ C}$ and $8.0 \times 10^{-19} \text{ C}$. Show these support charge quantisation, and state the value of e they imply.

[4]

- C2** Combine Millikan's $e = 1.60 \times 10^{-19} \text{ C}$ with Thomson's $e/m = 1.76 \times 10^{11} \text{ C kg}^{-1}$ to find the mass of the electron.

[3]

- C3** A student's analysis of oil-drop data yields a droplet charge of $4.0 \times 10^{-19} \text{ C}$. Explain why this result should send the student back to their working.

[2]